

## **METHOD AND APPARATUS FOR AN ENCRYPTING KEYBOARD**

### **Technical Field**

This invention relates to computer systems and, in  
5 particular, to the protection of personal information.

### **Background of the Invention**

Within the prior art, the problems of protecting  
personal or proprietary information have become  
increasingly important. Indeed, as the concepts of E-  
10 commerce have become more and more prevalent, the  
manner in which the proprietary or personal information is  
illegally obtained has increased. This is not only true of E-  
commerce being conducted over the Internet but also on  
Intranets within a commercial, governmental, or academic  
15 environment. One method that is used to obtain personal or  
proprietary information is the use of "keyboard-sniffers".  
Keyboard-sniffers are software or hardware based intrusions  
(also referred to as "bugs") that secretly record every  
keystroke on a computer and transmit/record it for later use  
20 by a third party who is illicitly gathering information. A  
keyboard-sniffer circumvents most password-protected  
encryption systems, by obtaining the personal or proprietary  
information before it can be encrypted. Software-based  
keyboard-sniffers can be manually installed on a computer  
25 system or may take the form of "virus" infestations being  
received from a network such as the Internet or Intranet.

One technique to protect against keyboard-sniffers  
is to attempt to prevent keyboard-sniffers from being installed

in the first place. This attempt suffers from the problem that the software techniques utilized to insert sniffers/viruses into computer systems are constantly evolving. In addition, hardware based keyboard-sniffers can be installed on an  
5 unattended computer in only a couple of minutes since all that is necessary is to simply insert a small device between the keyboard and the computer. Also, with the growing number of wireless keyboards, it is not necessary to physically insert hardware between the keyboard and the  
10 computer. With respect to wireless keyboards, all that is necessary is to locate a receiver within the transmission range of the wireless keyboard.

A second technique that the prior art has attempted to utilize to circumvent keyboard-sniffers is to display  
15 numbers and letters on the console of a computer and have the user utilize the mouse to point out the password by touching various numbers and letters on the console screen.

A third technique that has been utilized by some password and entry programs is to display on the console  
20 screen randomized character mapping for a user to perform on their own password before the user enters the password.

A fourth technique is to insert a hardware device into a link interconnecting a keyboard and a computer. The hardware device automatically generates a different  
25 password each time the user logs onto the computer or a server via the computer. (See the application note entitled "Using KeeLoq to Generate Hopping Passwords". Application note AN665, Microchip Technology, Inc., 1997).

These prior art techniques suffer from many problems including human factors, implementation, and limited use.

### **Summary of the Invention**

A method and keyboard for protecting data  
5 generated by the keyboard by reading data from a keypad of the keyboard, encrypting the read data, and transmitting the encrypted data from the keyboard to a computer.

A method for protecting by a computer data  
generated by a keyboard where the keyboard is connected  
10 to the computer by receiving encrypted data from the keyboard by the computer, and decrypting the encrypted data.

A method for protecting by a server data generated  
by a keyboard where the keyboard is connected to the server  
15 via a network and a computer by receiving encrypted data from the keyboard by the server, and decrypting the encrypted data.

### **Brief Description of the Drawing**

FIG. 1 illustrates, in block diagram form, various  
20 embodiments;

FIG. 2 illustrates, in flowchart form, various  
embodiments performed by a keyboard;

FIG. 3 illustrates, in flowchart form, various  
embodiments implemented by a computer to which a  
25 keyboard is connected; and

FIG. 4 illustrates, in flowchart form, various embodiments implemented by software being executed on a server.

### **Detailed Description**

5           FIG. 1 illustrates, in block diagram form, various embodiments that may be utilized to implement the invention. Keyboard 101 comprises processor 108 which provides overall control of keyboard 101. Keypad 111 is the keypad that typing and data entry is performed on.  
10           Indicators 110 include various indication lights such as a “NUM LOCKS” indicator. Memory 109 provides storage for routines and data. Interface 107 interconnects keyboard 101 to computer 102. Link 105 interconnecting keyboard 101 and computer 102 can be implemented in various protocols  
15           including a wireless protocol.

          In one embodiment, device reader 112 is utilized to read information from a security card or other such portable media. Device reader 112 may be a USB device, a PC card reader, or any other input device known to those skilled in  
20           the art. With the exception of device reader 112, the other elements of keyboard 101 are found in prior art keyboards. The difference between keyboard 101 and prior art keyboards is the manner in which control routine 114 and encryption routine 117 function.

25           Computer 102 may be any computer to which a keyboard is connected and is well known to those skilled in the art. Processor 119 provides overall control of computer 102 by the execution of programs and data stored

in memory 121. Operating system 124 provides the overall software control. Keyboard driver 126 interfaces with information being received from keyboard 101. WAN interface 127 provides the necessary interface routines to  
5 interconnect to WAN 123 via WAN interface 122. Console 120 provides visual information to a user of computer 102.

In one embodiment, device reader 125 is utilized by processor 119 to read information from a security card or  
10 other such portable media. Device reader 125 may be a USB device, a PC card reader, or any other input device known to those skilled in the art. An embodiment utilizing both device readers 112 and 125 can encrypt and decrypt information being transmitted from keyboard 101 to  
15 computer 102 via link 105. The information being inputted via keypad 111 is encrypted using information read from device reader 112 before transmission over link 105 (which may be a wireless link) and decrypted by processor 119 utilizing information received from device reader 125.

20 Wide area network (WAN) 103 provides interconnection between computers such as computer 102 and servers 104-106. WAN 103 may be, but is not limited to, the Internet, Intranet, local area network, etc.

Servers 104-106 provide a variety of services for  
25 computers such as computer 102. Servers 104-106 may also provide a number of other services without communication with a computer such as computer 102, as is well known to those skilled in the art.

Server 106 illustrates more details concerning a server. Note, that server 106 does not illustrate certain devices such as, but is not limited to, a console, mass storage, keyboard, etc. Processor 132 provides overall control of server 106 by executing programs and using data stored in memory 131. Operating system 134 provides overall software control utilizing WAN interface 138 to communicate via WAN 103. Applications 139-141 can perform a variety of activities. In the following examples, it is assumed that application 139 is performing an application that requires input of personal or proprietary information from keyboard 101 via computer 102.

Consider now the various embodiments that may be implemented by the apparatus illustrated in FIG. 1. First, consider the embodiments that allow encryption of information being inputted from keypad 111 to be encrypted by keyboard 101. The encryption is performed on data being received from keypad 111 by processor 108 executing encryption routine 117. In one embodiment, encryption routine 117 is permanently stored in memory 109 utilizing read only memory (ROM), flash memory, etc. Any type of permanent memory known to one skilled in the art can be utilized for the storage of encryption routine 117. In another embodiment, encryption routine 117 is stored in random access memory located in memory 109, and the encryption routine is loaded from device reader 112. In another embodiment, the encryption routine 117 is downloaded from computer 102 from keyboard driver 126 or an application such as application 128. In yet another embodiment,

encryption routine 117 is downloaded from a server such as server 106 executing application 139.

Once encryption routine 117 is stored, then a seed is utilized with encryption routine 117 to encrypt the data from keyboard 111. The seed may be entered manually on  
5 keyboard 111 by the user typing in information that the user had received in paper form or by observing the seed being displayed on console 120 by an application, such as applications 128-129 and 139-141 or keyboard driver 126. In  
10 another embodiment, the seed is received via device reader 112. In another embodiment, device reader 112 is reading a smart card such as the ActivCard Gold smart card manufactured by ActivCard Corp. To enable operation of the ActivCard, the user may need to enter a personal  
15 identification number (PIN) via keypad 111. Some indicators of indicators 110 may be utilized to indicate whether the correct PIN has been entered. Encryption routine 117 is responsive to the input from keypad 111 to enable the ActivCard in device reader 112 if the correct PIN has been  
20 received. One skilled in the art would readily see that an ActivCard could be utilized with device reader 125.

Keyboard 101, in particular processor 108, needs to determine when to start the encrypting process and when to terminate the encrypting process. In one embodiment, the  
25 encryption process is started when keyboard 108 is powered on. In another embodiment, the encryption process is started in response to a unique sequence of key actuations on keypad 111 by a user. This sequence may include, but is not limited to, multiple simultaneous key actuations. Indeed,

multiple key actuations can be performed which are not normally allowed by processor 108 executing control routine 114 or by processor 119 executing keyboard driver 126. In another embodiment, an extra key is added to keypad 111 that is utilized to start and stop the encrypting process. In another embodiment, keypad 111 may have a special key reserved solely for starting and stopping the encryption process. In another embodiment, the encryption process is started when device reader 112 signals processor 108 that it has information to upload to processor 108. In another embodiment, the encryption process is started by a routine or application in computer 109 or server 106 signaling keyboard 101 that the encryption should be started. Encryption is ended using one of the methods indicated for starting the encryption.

In one embodiment, encryption is utilized only to protect limited amounts of personal or proprietary information such as a password, credit card number, social security number, account numbers, etc. However, in another embodiment, keyboard 108 can always encrypt information being sent so that all information coming from keyboard 101 is encrypted.

Next, consider where the decryption is performed for the encrypted information being received from keyboard 101. In one embodiment, keyboard driver 126 performs the decryption so that all information being received from keyboard 101 is decrypted after leaving keyboard driver 126. In another embodiment, decryption is performed by an application such as application 128 in memory 121. In



yet another embodiment, the decryption is performed by an application such as application 139 in a server such as server 106. In addition, in another embodiment, computer 102 would utilize a specialized decryption routine  
5 stored in memory 121 but not illustrated in FIG. 1.

FIG. 2 illustrates, in flowchart form, embodiments of operations that are performed by a keyboard such as keyboard 101. After being started in block 201, decision block 202 determines if it is time to start performing the  
10 encryption operation. Decision block 202 can be responsive to a special key on keyboard 101, ennoblement of device reader 112, a special sequence entered by the user on keypad 111, or reception of a start encryption message from computer 102 or server 106 in the present examples. If  
15 decision block 202 determines that it is not time to start encrypting information entered on the keypad of the keyboard, control is transferred to block 208 which performs normal keyboard processing before transferring control back to decision block 202.

20 If decision block 202 determines that the encryption process is to start, control is transferred to decision block 203 to determine if the encryption code for an encryption routine such as encryption routine 117 is to be downloaded from an external source. In the various  
25 embodiments, this external source can be device reader 112, computer 102, or server 106. If the encryption code is to be downloaded from an external source, block 204 receives the encryption code and stores it within memory 109 of keyboard 101 before transferring control to decision

block 206. If the encryption code is not to be received from an external source, decision block 203 transfers control to decision block 206.

5        Decision block 206 determines if the seed that will be utilized by an encryption routine within the keyboard such as encryption routine 117 will be received from a device reader connected directly to the keyboard or will be entered via the keypad on the keyboard. Note, that in another embodiment, the encryption seed is transmitted to  
10        processor 108 from either computer 102 or server 106 in the present example. If the encryption seed is not to be received from the device reader, block 209 receives the encryption seed from the keyboard. The user enters the encryption seed via the keyboard by either reading the encryption seed  
15        information from a piece of paper or from a message displayed on console 120 of computer 102 by an application running in either computer 102 or server 106. After receiving the encryption seed, block 209 transfers control to decision block 216.

20        Returning to decision block 206, if the encryption seed is to be read from the device reader, control is transferred to decision block 207. The latter decision block determines if a PIN is needed to enable the information from the device reader. Such a PIN is required in the case of the  
25        utilization of an ActivCard. If no PIN is required, decision block 207 transfers control to block 211 which reads the seed from the device reader before transferring control to decision block 216.

If decision block 207 determines that a PIN is needed, control is transferred to block 212 which reads the PIN from information entered from keypad 111 under control of processor 108. Decision block 213 determines if the PIN  
5 is correct. If the PIN is not correct, decision block 213 transfers control back to block 212. If the PIN is correct, decision block 213 transfers control to block 214. The latter block enables the device reader and reads the seed from the device reader. One skilled in the art would readily realize  
10 how a smart card such as the ActivCard would be enabled so that the seed could be read from such a smart card. After execution of block 214, control is transferred to decision block 216.

Decision block 216 determines if data has been  
15 received from the keypad. If the answer is no, control is returned to decision block 216. Note, although not illustrated, one skilled in the art would readily realize that the operations of decision block 216 would also include receiving data from computer 102 to perform such functions as  
20 controlling indicators 110 while decision block 216 is determining if data is being received from keypad 111. If the answer is yes in decision block 216, block 217 encrypts the data and transmits it to computer 102. In one embodiment, computer 102 will decrypt the data upon receipt. In another  
25 embodiment, the decryption of the data from block 217 will be performed by an application in a server such as server 106.

After execution of block 217, control is transferred to decision block 218 to determine if the encryption process

should be stopped. The information that the encryption process should be stopped can be received in the same modes as the information that started the encryption process in decision block 202. If the answer in decision block 218 is  
5 no, control is transferred back to decision block 216. If the answer in decision block 218 is yes, control is transferred to decision block 202. Note, that the encryption process can be started by decision block 202 at any time and not necessarily when keyboard 101 is initially powered on. In addition, one  
10 skilled in the art would readily realize that a keyboard could respond to a variety of stimulus to start and stop the encryption process so that different applications and routines could utilize the capabilities of encrypting data by keyboard 101.

15 FIG. 3 illustrates, in flowchart form, embodiments of operations that would be performed by a computer such as computer 102 connected to a keyboard. These operations can be performed by keyboard driver 126 or an application such as application 128. Processor 119 is executing the  
20 driver or application. After being started in block 301, decision block 302 determines if it is time to start the encryption process. If the answer is yes, decision block 303 determines if the encryption code that will be utilized by the keyboard is to be downloaded from computer 102. If the  
25 answer is yes, block 304 transmits the encryption code to the keyboard 101 before transferring control to decision block 306. If the answer in decision block 303 is no, control is transferred to decision block 306. The latter decision block determines whether computer 102 is to transmit a signal to

keyboard 101 indicating that keyboard 101 is to start the encryption process. If the answer is no in decision block 306, control is transferred to decision block 308. If the answer is yes in decision block 306, block 307 transmits a  
5 start message to keyboard 101 before transferring control to decision block 308.

Decision block 308 determines if the decryption seed is to be obtained from a device reader such as device reader 125. If the answer is no, block 309 receives the  
10 decryption seed from software such as an application or keyboard driver 126 before transferring control back to decision block 302. If the answer in decision block 308 is yes, decision block 311 determines if a PIN is needed for operation of device reader 125. If the answer is no,  
15 block 312 reads the seed from the device in device reader 125 before transferring control back to decision block 302. If the answer is yes in decision block 311, block 313 reads the PIN which could be entered via the keyboard 101. Decision block 314 then determines if the  
20 PIN is correct before transferring control to block 316. If the PIN is not correct, block 313 is executed again. Block 316 enables the device and reads the decryption seed from the device in the device reader before transferring control back to decision block 302. One skilled in the art would  
25 immediately realize that blocks 302-316 could be performed in different orders.

Returning to decision block 302, if the answer is no, decision block 317 determines whether encryption is on. If the answer is no, control is transferred to block 322 which

performs normal processing before returning control back to decision block 302. If the answer is yes in decision block 317, block 318 utilizes the decryption seed to decrypt any keyboard data that may have been received from keyboard 101 before transferring control to decision block 319. Decision block 319 determines whether it is time to stop the encryption process. If the answer is no, control is transferred to block 322. If the answer is yes in decision block 319, block 321 stops the encryption process before transferring control to block 322.

FIG. 4 illustrates the operations that would be performed by a server such as server 106 during the execution of an application such as application 139. FIG. 4 illustrates various embodiments of the invention. After being started in block 401, decision block 402 determines if the encryption process should be started. If the answer is yes in decision block 402, decision block 403 determines whether the encryption code is to be downloaded from the server to the keyboard. If the answer is yes, block 404 downloads the encryption code before transferring control to decision block 406. If the answer is no in decision block 403, control is transferred to decision block 406. Decision block 406 determines if the software running on the server is to signal the keyboard to start performing encryption. If the answer is no, control is transferred to block 408. If the answer is yes in decision block 406, control is transferred to block 407 which transmits a start message to keyboard 101 before transferring control to block 408. Block 408 accesses the decryption seed from data stored in data 136 or built directly

into the application being executed before transferring control back to decision block 402.

Returning to decision block 402, if the answer is no, decision block 409 determines if the encryption process is  
5 active. If the answer is no, control is transferred to block 414. If the answer is yes in decision block 409, block 411 decrypts any data being received from the keyboard before transferring control to decision block 412. The latter decision block determines if there is any type of an  
10 indication to stop the encryption process. Normally, an application utilizing the encrypted information would signal the stop of the encryption process. If the answer is no in decision block 412, control is transferred to block 414. If the answer is yes in decision block 412, block 413 stops the  
15 encryption process which will entail informing the software executing the operations illustrated in FIG. 4 and also transmitting a message to keyboard 101 to cease performing encryption before transferring control to block 414. Block 414 performs normal processing before transferring  
20 control back to decision block 402.

When the operations of devices 101, 102, or 106 are implemented in software, as is shown in FIGS. 2-4, it should be noted that the software can be stored on any computer-readable medium for use by or in connection with  
25 any computer related system or method. In the context of this document, a computer-readable medium is an electronic, magnetic, optical, or other physical device or means that can contain or store a computer program for use by or in connection with a computer related system or method.

Devices 101, 102, or 106 can be embodied in any computer-readable medium for use by or in connection with an instruction execution system, apparatus, or device such as a computer-based system, processor-containing system, or  
5 other system that can fetch the instructions from the instruction execution system, apparatus, or device and execute the instructions. In the context of this document, a "computer-readable medium" can be any means that can store, communicate, propagate, or transport the program for  
10 use by or in connection with the instruction execution system, apparatus, or device. For example, the computer-readable medium can be, but is not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, device, or propagation  
15 medium. More specific examples (a non-exhaustive list) of the computer-readable medium would include the following: an electrical connection (electronic) having one or more wires, a portable computer diskette (magnetic), a random access memory (RAM) (electronic), a read-only memory  
20 (ROM) (electronic), an erasable programmable read-only memory (EPROM, EEPROM, or Flash memory) (electronic), an optical fiber (optical), and a portable compact disc read-only memory (CDROM) (optical). Note that the computer-readable medium could even be paper or another suitable  
25 medium upon which the program is printed, as the program can be electronically captured via optical scanning of the paper or other medium and then compiled, interpreted or otherwise processed in a suitable manner, if necessary, and stored in a computer memory.



In an alternative embodiment, where devices 101, 102, or 106 are implemented in hardware, devices 101, 102, or 106 can be implemented with any or a combination of the following technologies, which are each  
5 well known in the art: a discrete logic circuit(s) having logic gates for implementing logic functions upon data signals, an application specific integrated circuit (ASIC) having appropriate combinational logic gates, a programmable gate array(s) (PGA), a field programmable gate array (FPGA), etc.

10 Of course, various changes and modification to the illustrated embodiments described above will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the invention and without diminishing its intended advantages. It  
15 is therefore intended that such changes and modifications be covered by the following claims except insofar as limited by the prior art.